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August 30, 2011

Memorandum

TO: Cliff Ogburn, Town of Nags Head (NC)

FROM: HL Kaczkowski, Project Engineer & TW Kana, Project Director

RE: Nags Head Beach Nourishment [CSE 2203]
Hurricane *Irene* Impacts

Hurricane *Irene* made landfall at Cape Lookout (~75 miles from Nags Head) around 7:30 a.m. on August 27th. Maximum sustained wind speed was 90 mph (Category 1 hurricane) and the track was north-northeast at 14 mph. By early afternoon, the east edge of the eyewall was in the vicinity of Manteo. This path generated high waves at Nags Head (NC) from the southeast with winds veering east to southwest as the storm passed west of town. [Winds would have backed from east to northwest if the track had been off to the east of Town.] As a result, net sand movement was offshore and to the north during the storm. This means relatively little sand shifted south to the National Seashore.

Landfall coincided with high tide, so as the storm progressed up Pamlico Sound, the tide was falling at Nags Head. This had the favorable effect of reducing the peak water levels by as much as 4 feet (ft). On-scene reporters were able to stand on the nourished beach as the storm approached, although high waves continuously swashed over the nourishment berm during the height of the storm. There was no scarping of the foredune or undermining of homes in the nourished section (Small Street to about 700 ft north of McCall Ct). Even the condemned properties at Seagull Street made it through the storm without further damage. However, there was considerable erosion of the visible beach, particularly the nourished sections. See representative wind and tide data (Fig 1).

The Town and CSE are completing a comprehensive post-storm survey of sand losses due to *Irene*. On Sunday, the day after the storm, CSE collected data along the visible beach to low water in nourished and unnourished sections at 5000 ft spacing. On Monday, CSE collected ~13,000 data points for comprehensive coverage of the visible beach. Offshore data collection Tuesday (30 August) was not possible while CSE's personnel were waiting for sea conditions under brisk NE winds to diminish. Plans call for offshore profiling on Wednesday or Thursday as soon as waves diminish for work over the inshore area.

While there was considerable variability in the beach after the storm, these preliminary data from August 28-29 indicate the following changes.

1) Approximately 1.0 million cubic yards (~25 percent of the nourishment volume in place before the storm) was eroded from the visible beach. Surveys into deepwater this week (week of 29 August) will determine how much shifted to the zone between the low-tide line and the outer bar, and whether significant volumes were permanently lost to deep water. It appears the nourishment volume permanently lost will be well under 1.0 million cubic yards.

2) The average sand volume eroded from the visible beach in the nourished areas was 24 cubic yards per foot (cy/ft), whereas the volume eroded in the unnourished areas was 8 cy/ft.

3) Unnourished sections experienced an average dune recession of 15 ft, measured at the +7-ft contour (toe of dune). Nourished sections experienced an average buildup of sand at the +7-ft contour, widening by 44 ft.

4) Measured at the +5 ft contour (approximate seaward edge of the nourishment berm), the unnourished sections receded an average of 23 ft, whereas the nourished sections receded an average of 134 ft.

5) Measured at approximate mean sea level, unnourished sections receded an average of 17 ft, whereas nourished sections receded any average of 72 ft.

6) Measured at approximate mean low water, unnourished sections receded by an average of 28 ft, whereas nourished sections receded by 5 ft.

The average slope of the beach measured from the upper beachface to the low-tide mark changed little in the unnourished sections (1 on 17 along north Nags Head before *Irene* and 1 on 16 after the storm). The nourished sections averaged 1 on 13 before the storm (as-built condition) and 1 on 25 after the storm. Figure 2 illustrates the average changes along the visible beach in the nourished sections.

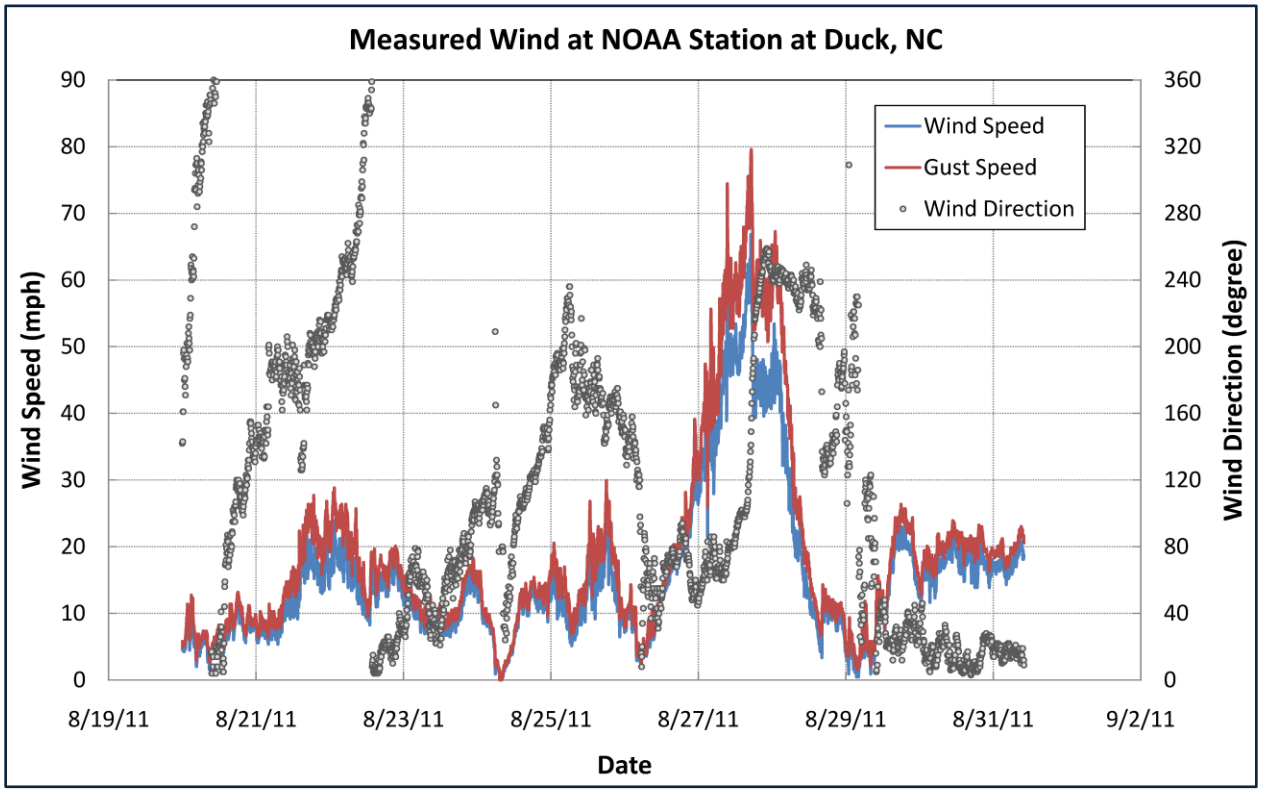
Within the nourished sections, the mean sea level contour moved an average of 72 ft closer to buildings. However, the same contour remained an average of 130 ft seaward of its position prior to nourishment. In the unnourished sections, the mean sea level contour is 23 ft closer to buildings.

Irene occurred after nearly 85 percent of the nourishment had been placed along Nags Head. Some sections had just received new sand days before, and nearly all sections had not fully adjusted. Adjustment of the nourishment profile means simply a shift of some sand from the visible beach to the underwater zone close to shore. *Irene* accelerated this process and, fortunately, the storm's intensity and surge were insufficient to penetrate across the nourishment berm and cut back the dunes. Even the condemned houses along Seagull Street remained standing after the storm.

Table A provides the data on which these observations are based. Readers are free to draw their own conclusions on whether or not the project provided benefits to the community during the storm.

TABLE A. Post-Irene beach changes at Nags Head, North Carolina. [Pre – 23 August 2011, Post – 28 August 2011]

Station	Nourished	Nourishment MSL Contour Movement (ft)	Post-storm Contour Movement (ft)				Slope Changes (+5 ft to -2 ft)		Volume Changes (dune toe to -2.2 ft)		
			@ 7 ft	@ 5 ft	@ 0 ft	@ -2 ft	Pre-Storm	Post-Storm	Nour Vol	Vol Loss	% eroded
450+00	No	NA	-30	-23	-22	-71	18	8	0	8.0	NA
500+00	No	NA	-12	-41	0	-8	18	15	0	5.6	NA
550+00	No	NA	-13	-25	-7	0	14	20	0	6.8	NA
600+00	No	NA	-11	-14	-7	-10	19	22	0	7.2	NA
650+00	Yes	88	-6	-123	-53	-10	10	26	50	25.6	51.3
700+00	Yes	137	10	-84	-52	-15	17	26	93	17.5	18.8
750+00	Yes	105	22	-115	-58	-49	20	24	80	25.8	32.2
800+00	Yes	202	132	-97	-20	-10	14	26	96	10.6	11.0
850+00	Yes	263	5	-250	-101	-68	12	27	130	38.1	29.3
900+00	Yes	208	0	-78	-52	-41	15	23	80	20.5	25.6
950+00	Yes	317	0	-128	-90	45	8	24	175	27.5	15.7
1000+00	Yes	301	187	-200	-148	112	9	21	156	29.1	18.7
1050+00	No	NA	-8	-11	-51	-50	33	29	0	12.6	NA
Average - Native Beach	n=5	NA	-15	-23	-17	-28	20	19	0.0	8.0	NA
Average - Nourished	n=8	203	44	-134	-72	-5	13	25	107.5	24.3	25.3



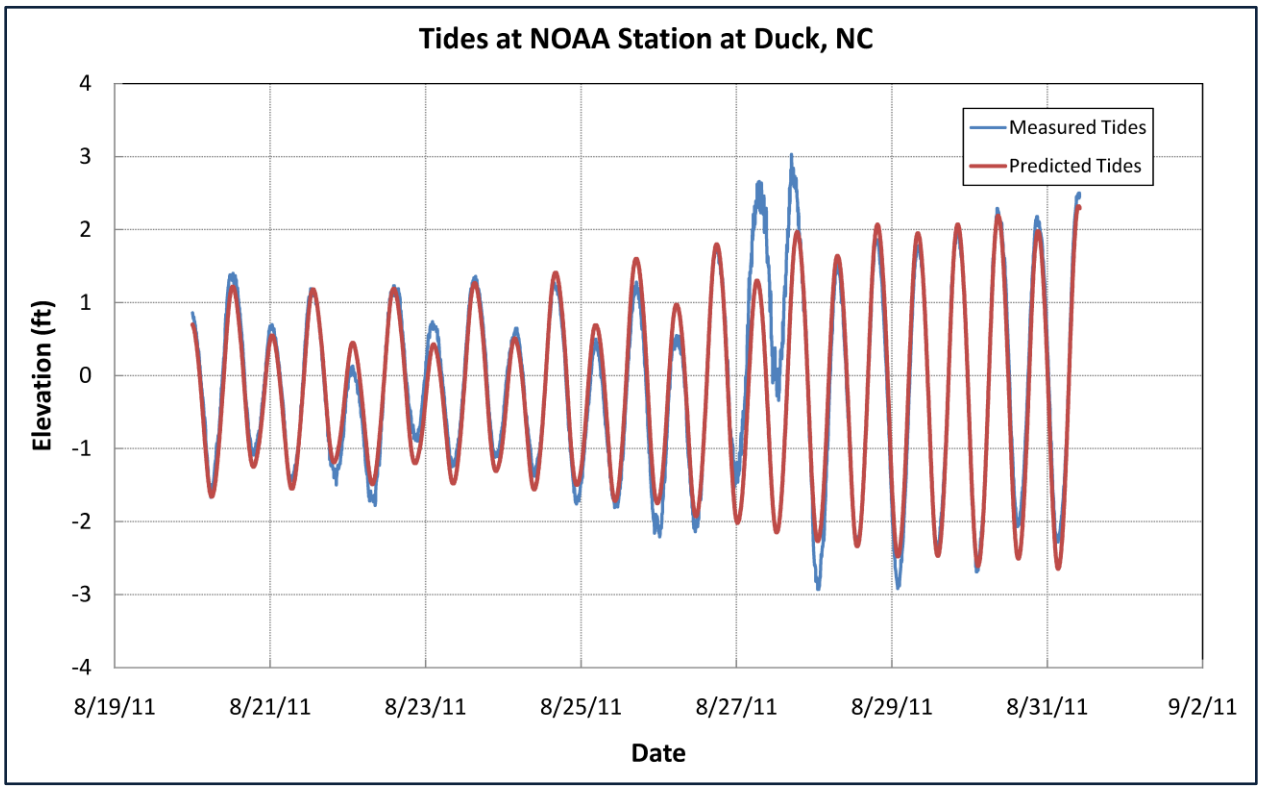


FIGURE 1. Wind and tide data.

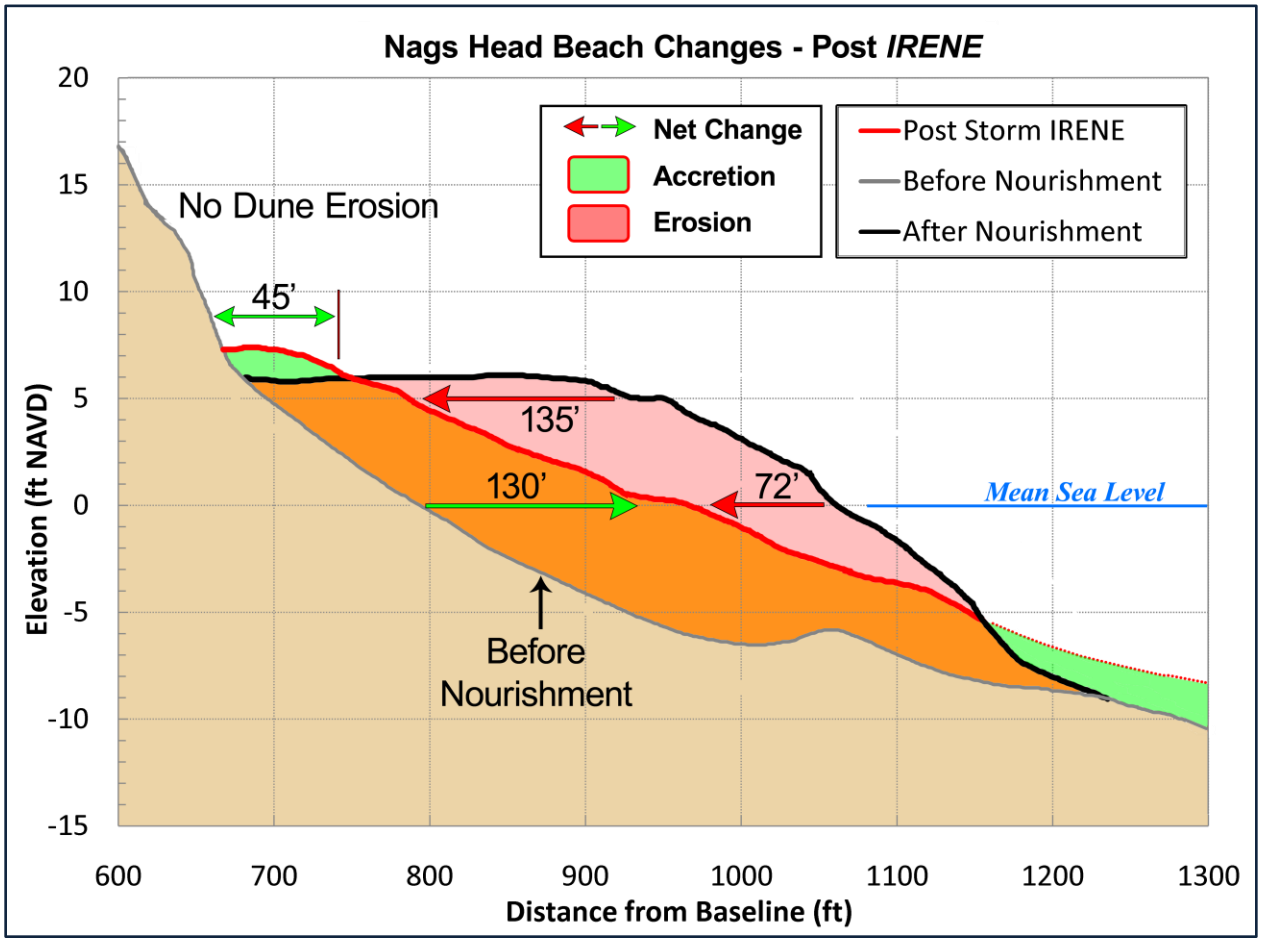


FIGURE 2. Average changes along the visible beach in the nourished sections.